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Title: An optical storage medium comprising a non-transparent bearing substrate and a method for making the same.

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Modtaget

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**AN OPTICAL STORAGE MEDIUM COMPRISING A NON-TRANSPARENT BEARING  
SUBSTRATE AND A METHOD FOR MAKING THE SAME**

**Field of the invention**

- 5 The present invention relates to an optical storage medium comprising a non-transparent bearing substrate and more specifically to an optical storage medium comprising at least one information surface supporting definition of at least a first nano-structure representing information in digital form. Furthermore the invention relates to a method for making said optical storage medium and the use of processes for making the optical storage medium.

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**Background of the invention**

- Generally optical storage media are known. Examples of optical storage media are Compact Discs (CD) and Digital Versatile Discs (DVD). The media comprises a bearing substrate on which a nano-structure representing information in digital form is provided on  
15 a first surface of the disc. The digital information is read from a second opposite side of the disc and thus the bearing substrate is transparent. The transparent material is a plastic material often poly-carbonate.

- In order to improve the reflection of a laser beam transmitted through the bearing  
20 substrate from the second side to the first side comprising the nano-structure, the nano-structure is provided with a reflective layer. It is critical for the media that the bearing substrate is transparent, as a laser beam can not be transmitted through a non-transparent substrate. On top of the reflective layer is often applied a lacquer. On the lacquer is often applied a colour print containing information about the media, such as the  
25 name of an artist and titles of e.g. the songs of the record.

- As the bearing substrate is made of a transparent material any kind of light, e.g. day light or a laser beam, is transmitted through the substrate. A known property of plastic substrates is that the substrate deteriorate when exposed to light and thus over time the  
30 quality of the disc decrease resulting in a disc which can not be read by e.g. a compact disc player or a CD-ROM drive. As optical storage media are also used for storing information it is desired that the disc is readable over time especially for archives comprising information which must be accessible for decades.

- 35 Due to the deteriorating nature of known optical storage media institutions storing information such as libraries, national archives etc. are reluctant to use the optical storage media. Thus the information storing institutions fail to obtain the advantages of the space saving media.

- 40 It is an aim of the present invention to provide an optical storage medium which overcomes the above mentioned disadvantages.

### Description of the invention

It is an object of the present invention to provide an optical storage medium comprising at least one information surface supporting definition of at least a first nano-structure  
5 representing information in digital form, the optical storage medium further comprising a bearing substrate comprising a substantially non-transparent material.

The optical storage medium may comprise one information surface e.g. when the medium is a Compact Disc or a CD-ROM, but the medium may also comprise a plurality of  
10 information surfaces such as two, such as three, such as four, such as five, such as six, such as seven, such as eight, such as nine, such as ten. The information surfaces may be provided side by side or on top of each other e.g. separated by layers such that the disc may comprise a multi-layer structure of information surfaces, e.g. such that the disc may be used as e.g. a DVD or a DVD-ROM. The information surfaces may extend in the same  
15 direction and/or be provided in the same plane, but could also be provided in planes being transverse to each other, e.g. the angle between at least a part of two planes may be 5 degrees, or 10 degrees, or 15 degrees or 20 degrees, or 30 degrees, or 40 degrees.

Each information surface may comprise one nano-structure but could also comprise a  
20 plurality of nano-structures dividing the information surface into a plurality of zones. The information surface may comprise two nano-structures, or three nano-structures, or four nano-structures, or five nano-structures, or six nano-structures, or seven nano-structures or eight nano-structures, or nine nano-structures. Some nano-structures may comprise information in digital form, while others are adapted to support definition of information in  
25 digital form. Some of the nano-structures may be changed once by application of an electromagnetic field and/or by an electromagnetic wave e.g. a laser beam while others may be changed a plurality of times.

The bearing substrate is non-transparent and thus little or no light may be transmitted  
30 through the substrate. In the present application the phrase 'bearing substrate' is understood such that the desired stiffness of the optical storage medium is not provided if the said substrate is not present. Thus the optical storage medium may collapse or not comprise a needed stability if the bearing substrate is not present.

The optical storage medium may be round such as elliptic or circular but the medium may also be a polygon such as a triangle or a quadrangle or a polygon with five edges or six  
35 edges or seven edges or eight edges or nine edges or ten edges. The polygonal shaped storage medium may have smooth edges e.g. such that the medium has substantially the same shape as a credit card or an access card. The optical storage medium may have the  
40 shape of a key-ring or a key for e.g. a door or any other shape.

In an embodiment the information surface may comprise a first nano-structure representing information in digital form. The information may be encoded but could also be non-encoded. The information may comprise an encoded part and a part comprising an

algorithm for decoding the information. The decoding algorithm may be mpeg 1, such as mpeg 1 - layer 3 (mp3), mpeg 4 or any other algorithm for compressing information.

5 The information surface may make the optical storage medium recognisable for an optical detecting device. An optical detecting device may be a device comprising a light emitting means and a means for detecting a reflected light beam, such as a Compact Disc player, such as a Compact Disc recorder or a DVD-drive or a Laser disc or a DVD-player or a DVD-recorder or a CD-ROM drive or a DVD-ROM drive. The information surface may be recognisable due to information stored on said surface. The information may by  
10 information about tracks on the medium or could be information about the capacity of the optical storage medium.

In an embodiment the bearing substrate may comprise at least one metallic material, thus the bearing substrate in this embodiment is non-transparent and deterioration due to  
15 exposure to light is eliminated. In another embodiment the bearing substrate may be a non-metallic material selected from the group consisting of glass, polymers, elastomers, paper, cardboard, wood or any combination thereof. E.g. the glass may be coloured e.g. black such that it is non-transparent. Additionally a substrate comprising polymers or elastomers may comprise a colour such that light can not deteriorate the plastic material.  
20 In an embodiment the substrate is made of cardboard and thus the optical storage medium may be embossed into a e.g. a A4-shaped piece of cardboard. The storage medium may be embossed such that a weakened line separates the optical storage medium from the rest of the cardboard. In another embodiment the cardboard is covered with structure supporting layer e.g. a lacquer on which the information surface is provided.

25 The optical storage medium may further comprise a second nano-structure supporting definition of the first nano-structure. The definition of said second nano-structure may be required for the optical storage medium to be recognisable for an optical detecting device. The information surface may comprise at least one geometrical structure supporting  
30 definition of the first nano-structure. The geometrical structure may be one track but could also be a plurality of tracks. The information surface may comprise a nano-structure comprising a plurality of pits, a pit being a point on the surface where the surface is elevated. The pits may be provided on the information surface such that they extend in the same direction so as to form a geometrical structure.

35 The geometrical structure may comprise a first zone defining a first nano-structure and/or a second zone defining the second nano-structure. The first nano-structure may be provided with a plurality of pits. A groove may be provided in the second nano-structure. The groove may support definition of a nano-structure representing information in digital  
40 form. The groove may be provided in the information surface. The information surface may be provided on one surface of the optical storage medium but could also be provided on two opposite sides of the storage medium.

The geometrical structure may form a helix, but the optical storage medium may also comprise a plurality of concentric geometrical structures. The information may be provided such that it should be read from centre of the medium and outwards, but could also be provided such that it should be read from the outer edge and inwards. The geometrical structure may be provided in structures extending radially on the optical storage medium-

The bearing substrate may comprise a first and an opposite second surface, at least one of said surfaces may comprise at least a one information surface. In one embodiment both the first and the second surfaces are information surfaces.

10 The optical storage medium may further comprise a first substrate having a first and a second surface, the first substrate being substantially parallel to a plane defined by the bearing substrate. In an embodiment at least a part of the first substrate may define a plane transverse to the bearing substrate such as defining an angle of 5 degrees, such as 10 degrees, such as 15 degrees, such as 20 degrees, such as 25 degrees, such as 30 degrees.

20 At least one of the first and the second surfaces of the first substrate may comprise at least one information surface. In an embodiment both the first and the second surface may be an information surface. The two information surfaces may constitute the two layers in an Digital Versatile Disc.

25 The optical storage medium may further comprise a second substrate having a first and a second surface, the second substrate being substantially parallel to a plane defined by the bearing substrate and/or the first substrate. In an embodiment at least a part of the second substrate may define a plane transverse to the bearing substrate and/or the first substrate such as defining an angle of 5 degrees, such as 10 degrees, such as 15 degrees, such as 20 degrees, such as 25 degrees, such as 30 degrees.

30 At least one of the first and the second surfaces of the second substrate may comprise at least one information surface. In an embodiment both the first and the second surfaces may be information surfaces.

35 The optical storage medium may further comprise a third substrate having a first and a second surface, the third substrate being substantially parallel to a plane defined by the bearing substrate and/or the first substrate and/or the second substrate. In an embodiment at least a part of the third substrate may define a plane transverse to the bearing substrate and/or the first substrate and/or the second substrate such as defining an angle of 5 degrees, such as 10 degrees, such as 15 degrees, such as 20 degrees, such as 25 degrees, such as 30 degrees.

40 At least one of the first and the second surfaces of the third substrate may comprise at least one information surface. In an embodiment both the first and the second surfaces may be information surfaces.

The optical storage medium may further comprise a fourth substrate having a first and a second surface, the fourth substrate being substantially parallel to a plane defined by the bearing substrate and/or the first substrate and/or the second substrate and/or the third substrate. In an embodiment at least a part of the fourth substrate may define a plane transverse to the bearing substrate and/or the first substrate and/or the second substrate and/or the third substrate such as defining an angle of 5 degrees, such as 10 degrees, such as 15 degrees, such as 20 degrees, such as 25 degrees, such as 30 degrees.

At least one of the first and the second surfaces of the fourth substrate may comprise at least one information surface. In an embodiment both the first and the second surfaces may be information surfaces.

The optical storage medium may comprise further substrates such as a fifth substrate, such as a sixth substrate, such as a seventh substrate, such as an eighth substrate, such as a ninth substrate, such as a tenth substrate. Said substrates may comprise any of the features of the bearing substrate or the first, second, third or fourth substrate.

The bearing substrate may comprise a reflective surface providing the desired reflective properties. The reflective surface e.g. tin may have the reflective properties with or without being polished. At least a part of at least one information surface may be covered with a reflective layer. The layer or the reflective surface of the bearing substrate may reflect all light emitted to the surface but may also emit 90 %, such as 80 %, such as 70 %, such as 60 %, such as 50 %, such as 40 %, such as 30 %. The reflective layer may be a semi-reflective layer. As an example the semi-reflective layer may either reflect or transmit the majority of light emitted to the layer and thus absorb little of the light. In an embodiment the reflective layer may comprise a metallic material. The metallic material may be polished so as to enhance the reflective properties.

An information surface of the bearing substrate may be reflective. An information surface of the first, second, third or fourth substrate may also be reflective. In an embodiment a first layer may be reflective while another may be semi-reflective. The reflective layer may be provided between the bearing substrate and the semi-reflective layer.

The optical storage medium may comprise a multi-layer structure provided on the first surface of the bearing substrate. In an embodiment a multi-layer structure may be provided on the second surface of the bearing substrate. Furthermore both the first and the second surface of the bearing substrate may be provided with a multi-layer structure.

The multi-layer structure may comprise the first substrate and/or the second substrate and/or the third substrate and/or the fourth substrate or any other additional substrates. In an embodiment the order of the substrates in the multi-layer from the bearing structure and outwards may be; first, second, third and fourth substrate. But the order of the

substrates may also be any other, such as second, first, fourth and third substrate. In an embodiment with a multi-layer structure on the first and second surface of the bearing substrate, the order of the first, second, third and fourth substrates may be the same on both sides seen from the bearing substrate and outwards. In another embodiment the order may be different for the two multi-layer structures.

The multi-layer structure may comprise the first substrate, at least a part of said first substrate being connected to the surface on the bearing substrate on which the multi-layer structure is provided. Only a part of the first substrate may be connected to the bearing substrate but the whole substrate may also be connected to the bearing substrate.

The multi-layer structure may further comprise the second substrate, at least a part of said second substrate being connected to a surface of the first substrate. Only a part of the second substrate may be connected to the first substrate but the whole substrate may also be connected to the first substrate. In an embodiment a part of one side of the second substrate may be connected to the first substrate while a part of the same side of the second substrate is connected to the bearing substrate.

In an embodiment the multi-layer structure may further comprise the third substrate, at least a part of said third substrate being connected to a surface of the second substrate. Only a part of the third substrate may be connected to the second substrate but the whole substrate may also be connected to the second substrate. In an embodiment a part of one side of the third substrate may be connected to the second substrate while a part of the same side of the third substrate is connected to the first substrate, while yet another part of the same side of the third substrate is connected to the bearing substrate.

According to the invention the multi-layer structure may further comprise the fourth substrate, at least a part of said fourth substrate being connected to a surface of the third substrate. Only a part of the fourth substrate may be connected to the third substrate but the whole substrate may also be connected to the fourth substrate. In an embodiment a part of one side of the fourth substrate may be connected to the third substrate while a part of the same side of the fourth substrate is connected to the second substrate, while yet another part of the same side of the fourth substrate is connected to the first substrate, while a further part of the same side of the fourth substrate is connected to the bearing substrate.

The first side and/or the second side of the first and/or the second and/or the third and/or the fourth substrate may be provided with a lacquer and/or an information surface and/or a reflective layer and/or a transparent layer and/or a semi-transparent layer and/or a magnetic layer.

In an embodiment the propagation rate of an electromagnetic wave in the first substrate may be lower than the propagation rate of the electromagnetic wave in the second substrate, such as 10 percent lower, such as 20 percent lower, such as 30 percent lower,

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such as 40 percent lower, such as 50 percent lower, such as 60 percent lower, such as 70 percent lower, such as 80 percent lower, such as 100 percent lower or 200 percent lower.

5 The coefficient of reflection of the first substrate may be higher than the coefficient of reflection of the second substrate, such as 10 percentage points higher, such as 20 percentage points higher, such as 30 percentage points higher, such as 40 percentage points higher, such as 50 percentage points higher, such as 60 percentage points higher, such as 70 percentage points higher, such as 80 percentage points higher, such as 90 percentage points higher or vice versa.

10 The following formula could be used for the calculation of the difference in the focal point when changing from a CD made from poly-carbonate to a CD made from a metal substrate.

15 The first parameter which must be known is the opening angle of the laser beam, which angle is the angle of the beam in relation to the surface of the CD. In the following, this angle is referred to as  $\alpha_{\text{inc}}$ . The angle is measured in relation to the axis of incidence.

20 The index of refraction of air  $n_{\text{air}}$  is set to 1. The index of poly-carbonate  $n_{\text{CD}}=1.55$ .

$$\begin{aligned} 1 \quad & n_{\text{air}} \sin(\alpha_{\text{air}}) = n_{\text{CD}} \sin(\alpha_{\text{CD}}) \\ 2 \quad & d_{\text{air}} = d_{\text{CD}} \frac{\tan(\alpha_{\text{CD}})}{\tan(\alpha_{\text{air}})} \end{aligned}$$

25 The angle of incidence of the laser beam is 26,744 deg.  
If this value is inserted into the formula no. 1, an angle of 16,877 deg. inside the CD is calculated.

By using formula no. 2, it is possible to calculate how much the focal distance on the information surface of the CD is moved when the CD is replaced by air. If the angles and the thickness of the CD of 1,2 mm.  $d_{\text{air}}=0,721$  mm. is calculated.

30 The propagation rate of an electromagnetic wave in the second substrate may be lower than the propagation rate of the electromagnetic wave in the third substrate, such as 10 percent lower, such as 20 percent lower, such as 30 percent lower, such as 40 percent lower, such as 50 percent lower, such as 60 percent lower, such as 70 percent lower, such as 80 percent lower, such as 100 percent lower or 200 percent lower.

The coefficient of reflection of the second substrate may be higher than the coefficient of reflection of the third substrate, such as 10 percentage points higher, such as 20 percentage points higher, such as 30 percentage points higher, such as 40 percentage



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points higher, such as 50 percentage points higher, such as 60 percentage points higher, such as 70 percentage points higher, such as 80 percentage points higher, such as 90 percentage points higher or vice versa.

- 5 According to an embodiment of the present invention the propagation rate of an electromagnetic wave in the third substrate may be lower than the propagation rate of the electromagnetic wave in the fourth substrate, such as 10 percent, lower such as 20 percent lower, such as 30 percent lower, such as 40 percent lower, such as 50 percent lower, such as 60 percent lower, such as 70 percent lower, such as 80 percent lower, such as 100 percent lower or 200 percent lower.

- 15 The coefficient of reflection of the third substrate may be higher than the coefficient of reflection of the fourth substrate, such as 10 percentage points higher, such as 20 percentage points higher, such as 30 percentage points higher, such as 40 percentage points higher, such as 50 percentage points higher, such as 60 percentage points higher, such as 70 percentage points higher, such as 80 percentage points higher, such as 90 percentage points higher.

- 20 In an embodiment the first substrate and/or second substrate and/or the third substrate and/or the forth substrate may be a semi-transparent material.

- Basically, electromagnetic radiation within the spectrum of light, is dampened in metal as in any other material, i.e. exponentially. The difference between metal and other materials is merely that the process occur much faster in metallic materials. Typical values for the thickness of a reflective surface can be estimated from the formula:

$$d = \frac{\lambda_0}{4\pi n_k}$$

- 30 Wherein d is the layer thickness which dampens (reflects) the light  $1/e \approx 0,37$ , or, in other terms, wherein 63% of the light is transmitted.  $\lambda_0$  is the wavelength of the laser light in vacuum (in this case, the value is substantially the same as for air), i.e. 780 nm.  $n_k$  is a value which contains both the refractive index and the absorption coefficient for the material. In the case of a natrium lamp, with the wavelength of 5893 Å (589,3 nm) the value is 2,83. It is for this purpose sufficient to provide an estimate for the thickness of the reflective layer. It should be noted that this constant varies strongly in the blue and ultraviolet part of the spectrum. Moreover, the constant is strongly dependent upon the pureness of the material, especially for metals like Au, Ag og Al wherein the pureness is important. Therefore, in each individual case, a measurement of the relectivity should be undertaken on the basis of an actual surface.

When the above mentioned values are inserted into the formula, a thickness of 16,5 nm @ 589 nm is calculated.

For further details, reference is made to the book "Principles of Optics" written by Born and  
5 Wolf.

The first substrate and/or the second substrate and/or the third substrate and/or the fourth substrate may be a transparent substrate.

- 10 In an embodiment at least one substrate of the multi-layer structure may be a peelable foil adhesively bonded to the bearing substrate and/or a substrate of the multi-layer structure. All the layers of the multi-layer structure may be peelable foils. In an embodiment only a part to the layers of the multi-layer structure are peelable such as the three layers farthest off the bearing substrate, such as the two layers farthest off the bearing substrate, such as
- 15 the layer farthest off the bearing substrate. In an embodiment every second layer in the multi-layer structure is a peelable foil, thus when a foil is peeled off two layers are removed from the optical storage medium, each of the two layers may comprise an information surface. In the latter embodiment it is possible to peel off two layers constituting a pair of DVD-layers.
- 20 The peelable foil may comprise a slip for removal of the foil from the substrate. Furthermore the peelable foil may in a peeled state be non-re-applicable to a surface of the optical storage medium. In the latter embodiment the foil may be used to detect if the optical storage medium has been used. Thus a non-transparent peelable layer may be
- 25 applied to the surface of the multi-layer structure preventing recognition of the storage medium by an optical detecting means. When the foil is peeled off the storage medium may be read but as the foil is not re-applicable it is possible to see that the storage medium has been used.
- 30 In another embodiment the peelable foil comprises an information surface on which a first software is located. Underneath the peelable foil a second information surface may be positioned comprising a second software. The first software may be used to set up a computer so as to enable it to use the second software, thus when the first software has been loaded into the computer the peelable foil may be removed so as to make it possible
- 35 to read the second software. This may be a way to ensure that a programme is only installed into ONE computer e.g. when information from the first and the second software is needed to run an application. In an other embodiment the peelable foil may be a programme which needs to be loaded into a computer while the second information surface supports definition of a nano-structure e.g. it may be possible to write/record
- 40 information on the second information surface.

Furthermore a supporting means may extend from a plan defined by the bearing substrate and/or the multi-layer structure. The supporting means may be used to ensure that a

desired distance is provided from a laser adapted to read or write on the storage medium so that a desired focus of e.g. a laser beam is obtained. The supporting means may also be adapted to protect an information surface of the optical storage medium as it may elevate the information surface from a surface e.g. a table on which the optical storage medium is placed. Thus dirt or small particles will not damage the information surface.

5 The supporting means may be formed by a curled edge portion of the bearing substrate and/or the multi-layer structure substrate. The curled edge portion may be a portion which is bent so that it comprises a curved part and a part which has a cross-section which extends in substantially the same direction. The curl portion may also be shaped such that a cross-section may define at least a part of a helix.

The storage medium may be provided with a centre hole. The hole may be provided in the centre of the bearing substrate, but could also be provided in another part of the substrate different from the centre of gravity of the optical storage medium.

15 The curled edge-portion may be formed along an edge of the centre hole. Furthermore the curled edge-portion may be formed along an outer peripheral edge of the bearing substrate and/or the multi-layer structure. The optical storage medium may comprise a curl portion along both the centre hole and the outer peripheral edge. The curled edge portion of the centre hole and the curled edge portion of the outer peripheral edge may extend in substantially the same direction in relation to the plane defined by the bearing substrate and/or the multi-layer structure. But the curled edge portions may also extend in opposite directions. The curled edge portions may define an angle in relation to a plane defined by the bearing substrate and/or the multi-layer structure of 90 degrees, such as 80 degrees, such as 70 degrees, such as 60 degrees, such as 50 degrees, such as 45 degrees, such as 40 degrees, such as 30 degrees, such as 20 degrees, such as 10 degrees.

20 The optical storage medium may further comprise detachable protecting means for protecting at least a part of the nano-structure. The protecting means may cover a part of the information surface but could also protect the entire information surface. The protecting means may be adapted to engage the centre hole of the substrate. But the protecting means may also be adapted to engage the outer periphery of the optical storage medium. The means for engaging the optical storage medium may be means such as snap-locks which may make it possible to attach the protecting means to the optical storage medium again and again.

30 The peripheral surface of the protecting means may be shaped as a polygon, such as a quadrangle or a triangle, such as a polygon with five edges, such as a polygon with six edges, such as a polygon with seven edges, such as a polygon with eight edges, such as a polygon with nine edges, such as a polygon with ten edges. The protecting means may be shaped so as to enable positioning of the protecting means side by side with conventional CD-covers. Thus the protecting means may comprise an edge or a side adapted to contain

information about the content of the optical storage medium e.g. the name of an artist or the name of a software application provided on an information surface of the substrate.

5 The bearing substrate may be made of a metal or an alloy, the metal or alloy comprising iron and/or steel and/or aluminium and/or magnesium and/or titanium and/or copper and/or nickel and/or zinc and/or cadmium and/or tin and/or lead and/or chrome and/or wolfram and/or silver and/or gold and/or platinum and/or stainless steel and/or tinplate and/or molybdenum. The bearing substrate may also be made of a non-transparent material comprising pieces of a metal so as to provide a stronger material.

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In an embodiment the first substrate and/or second substrate and/or third substrate and/or the fourth substrate may comprise a non-metallic material. The non-metallic material may comprise an amount of a metallic material which may be magnetic. The non-metallic material may be semi-transparent, but could also be transparent. The non-metallic  
15 material may be selected from the group consisting of lacquers, polymers, elastomers, laminated plastic, printing inks or any combination thereof. The non-metallic material may also be made of a paper material such as card board. In an embodiment the medium may be made of cardboard in such a way that the medium may be comprised in e.g. a box made of card board. A weakening line may make it possible to press the medium out of the  
20 surface of the box. Thus the medium may be part of a package comprising e.g. cereals and a commercial for another product may be embedded in the surface of the box comprising the cereals.

The reflective layer may comprise a highly refractive material selected from the group  
25 consisting of aluminium, silver, gold, platinum, chrome, titanium dioxide and zirconium dioxide and any combination thereof. The reflective may also comprise alloys made from the aforementioned refractive materials. In an embodiment the bearing substrate is made of a material which may be polished so as to provide the reflective surface.

30 At least one of the reflective layers may comprise an active reflective layer which may be changed between a non-reflective position and a reflective position. The active reflective layer may be switched between a transparent state and a state where the screen is highly reflective, but the active reflective layer may also be switched to any semi-reflective position so as to reflect 90 % of an electromagnetic wave, such as 80 %, such as 70 %  
35 such as 60 %, such as 50 %, such as 40 %, such as 30 %, such as 20 %, such as 10 %.

The active reflective layer comprises floating crystals adapted to be changed between the two positions. The floating crystals may be those known from LCD-screens. An LCD screen or the properties and functionality of such a screen may be provided in the substrate. Thus  
40 the entire screen/layer may be reflective. In another embodiment only a part of the screen is reflective e.g. while another is semi-reflective. The active layer may be adapted to show pictures e.g. black and white pictures in the layer/LCD-screen.

- Thus the optical storage medium may comprise an active reflection layer and make it possible to access information in some layers in special situations. In an embodiment the optical storage medium may comprise a multi-layer structure comprising one or more layers having the properties of an LCD-screen. When a laser beam is directed to the medium a layer in e.g. the middle of the storage medium may not reflect the laser beam or may provide poor reflection of the laser beam if the LCD-screen like layer is not turned on. When the LCD-screen like layer is turned on a full or nearly full reflection may be provided and thus the information stored in the layer may be read.
- 10 The thickness of the bearing substrate may be selected within the range 100-1400  $\mu\text{m}$ , such as within the range 125-1000  $\mu\text{m}$ , such as within the range 150-800  $\mu\text{m}$ , such as within the range 175-600  $\mu\text{m}$ , such as within the range 200-400  $\mu\text{m}$ , such as 225 $\mu\text{m}$ , such as 250  $\mu\text{m}$  such as 275  $\mu\text{m}$ , such as 300  $\mu\text{m}$ , such as 325  $\mu\text{m}$ , such as 350 $\mu\text{m}$ , such as 375 $\mu\text{m}$ .
- 15 The thickness of the first substrate may be selected within the range 0,1-1000  $\mu\text{m}$ , such as within the range 0,5-750  $\mu\text{m}$ , such as within the range 1-500  $\mu\text{m}$ , such as within the range 1,5-250  $\mu\text{m}$ , such as within the range 2-75  $\mu\text{m}$ , such as within the range of 5-10  $\mu\text{m}$ , such as within the range of 100-300  $\mu\text{m}$ .
- 20 The thickness of the second substrate may be selected within the range 0,1-500  $\mu\text{m}$ , such as within the range 2-450  $\mu\text{m}$ , such as within the range 4-400  $\mu\text{m}$ , such as within the range 6-350  $\mu\text{m}$ , such as within the range 8-325  $\mu\text{m}$ , such as within the range of 10-300 $\mu\text{m}$ .
- 25 The thickness of the third substrate may be selected within the range 0,1-500  $\mu\text{m}$ , such as within the range 2-450  $\mu\text{m}$ , such as within the range 4-400  $\mu\text{m}$ , such as within the range 6-350  $\mu\text{m}$ , such as within the range 8-325  $\mu\text{m}$ , such as within the range of 10-300 $\mu\text{m}$ .
- 30 The thickness of the fourth substrate is selected within the range 0,1-500  $\mu\text{m}$ , such as within the range 2-450  $\mu\text{m}$ , such as within the range 4-400  $\mu\text{m}$ , such as within the range 6-350  $\mu\text{m}$ , such as within the range 8-325  $\mu\text{m}$ , such as within the range of 10-300 $\mu\text{m}$ .
- The total thickness of the optical storage medium including the bearing substrate and/or one or more layers and/or reflective layers may be selected within the range 100-1400  $\mu\text{m}$ , such as within the range 125-1000  $\mu\text{m}$ , such as within the range 150-800  $\mu\text{m}$ , such as within the range 175-600  $\mu\text{m}$ , such as within the range 200-400  $\mu\text{m}$ , such as 225 $\mu\text{m}$ , such as 250  $\mu\text{m}$  such as 275  $\mu\text{m}$ , such as 300  $\mu\text{m}$ , such as 325  $\mu\text{m}$ , such as 350 $\mu\text{m}$ , such as 375 $\mu\text{m}$ .
- 40 When designing the optical storage medium the thickness, the refractive index of the layers and the dimensions of the supporting means e.g. the curl portion may be designed such that the focus of the laser beam directed towards the optical storage medium may be acceptable so as to read the information on the optical storage medium

- The thickness of the reflective layer may be selected within the range of 0,01-1 $\mu$ m, such as within the range of 0,02-0,09  $\mu$ m, such as within the range of 0,03-0,08  $\mu$ m, such as within the range of 0,04-0,07  $\mu$ m, such as within the range of 0,05-0,06  $\mu$ m, such as 0,05  $\mu$ m. As the reflective layer may comprise an LCD-like layer the thickness may be selected within the range 100-1400  $\mu$ m, such as within the range 125-1000  $\mu$ m, such as within the range 150-800  $\mu$ m, such as within the range 175-600  $\mu$ m, such as within the range 200-400  $\mu$ m, such as 225 $\mu$ m, such as 250  $\mu$ m such as 275  $\mu$ m, such as 300  $\mu$ m, such as 325  $\mu$ m, such as 350 $\mu$ m, such as 375 $\mu$ m.
- 10 The thickness of the curl portion may be within the range 100-1500  $\mu$ m, such as within the range 300-1400  $\mu$ m, such as within the range 500-1350  $\mu$ m, such as within the range 750-1300  $\mu$ m, such as within the range 1000-1250  $\mu$ m, such as substantially 1200  $\mu$ m. The thickness of the curl portion may be determined as de scribe in the best mode of
- 15 carrying out the invention - see description of fig. 8. The plane defined by the outer surface of the storage medium may be positioned in the opposite direction than the direction in which the curl portion extends. The curl portion may also be used to provide the desires focus of the laser beam.
- 20 In an embodiment the bearing substrate and/or the first substrate and/or the second substrate and/or the third and/or the fourth substrate may be provided with a colour print layer. The colour print layer may be provided on both sides of any substrate in the optical storage medium. The colour print may comprise a logo, a trademark, a picture, a stereogram, information about the content of the optical storage medium or any other kind
- 25 of print. The colour print may be substantially transparent or may be semi-transparent such that a laser beam or any other electromagnetic wave may be able to pass through the colour print.
- The colour print layer may be positioned between the bearing substrate and the first
- 30 substrate. The colour print layer may be positioned between the first substrate and the second substrate. The colour print may be positioned between the second substrate and the third substrate. The colour print may be positioned between the third substrate and the fourth substrate. The colour print layer may be provided on a side of the fourth substrate opposite the third substrate. The colour prints of the different layer may be
- 35 provided such that a picture or a desired visual effect is not obtained by the print on only one layer, but only by the colour prints of all or some of the layers. This may provide the effect that a first picture is visible when the pealable layer is provided on the optical storage medium, but when the pealable layer is removed the picture is different or missing. The latter embodiment may make it possible so easy detect if the pealable layer
- 40 has been removed.

At least one substrate in the multi-layer structure may be coloured, such as blue, green, reed or any other colour. The layers may comprise different colours such that when the

pealable layer is attached to the optical storage medium one colour is seen (e.g. green), but when the pealable foil, which may be yellow, is removed a blue colour is seen.

In an embodiment the digital information represented in the nano-structure may be audio and/or video and/or data, such as data for a computer, such as data for a computer game application. The digital information may comprise a multi-channel sound such as 5.1 channels e.g. dolby digital but the information may also comprise DTS sound and could comprise a combination of sound and picture such that a movie picture may be stored on the optical storage medium. The optical storage medium may comprise computer games e.g. combined with a movie picture. The information may be music or speech or noise or a recording of sound in nature or a recording of any other kind of sound.

The nanostructure may represent an image and/or text, such as a hologram. The hologram may be used to provide a sign of the authenticity of the optical storage medium and thus show that the medium is not a copy. The different layers of the optical storage medium may comprise one or more holograms, this may provide a special visual effect as a resulting hologram may be obtained.

The optical storage medium may be a Compact Disc, such as an audio CD, such as a super audio CD. The optical storage medium may be a CD-ROM, such as a read-only CD-ROM, such as a recordable CD-ROM, such as a re-writable CD-ROM. The optical storage medium may be a multy-layer medium, such as a DVD, such as a DVD+R/W such as a DVD-R/W such as a DVD-ROM. The optical storage medium may be e.g. a part of a disc-drive medium, such as a floppy disc such as a hard disc. Furthermore the optical storage medium may be a part of minidisc medium or a part of a can e.g. a lid or a side wall or a bottom part such that the medium may be defined in the can by a weakning line making it possible to press out and separate the optical storage medium. In another embodiment the storage medium may be glued or heat sealed on the can e.g. a side-wall, a bottom part or a top part of a can.

The optical storage medium may be adapted to be read by laser-source and/or an x-ray-source and/or an magnetic-resonance source. The optical storage medium may be used in a MR-scanner as a programme for the same or a means of updating the software in said MR-scanner. The optical storage medium may be provided such that the information surfaces may only be read by two lasers or three lasers or four lasers or five lasers.

According to a second aspect the invention relates to a method of making an optical storage medium comprising a bearing substrate, the bearing substrate comprising a substantially non-transparent material, said method comprising the steps of:

- forming an information surface into a surface of the optical storage medium, the information surface supporting definition of a first nano-structure representing information in digital form.

The step of forming the information surface may comprise forming a information surface readable to e.g. a CD-drive thus the information surface may comprise information such as sound, pictures etc. The step of forming the information surface may comprise the step of preparing the optical storage medium for recording or writing information into the  
5 information surface such as providing the geometrical structure described above. Thus the result of the process according to the first aspect of the invention may be a recorded or a recordable optical storage medium.

The method may further comprise the step of forming a first nano-structure into the  
10 information surface, the first nano-structure representing information in digital form.

The information surface may be provided on the bearing substrate. The step of forming the information surface into the bearing substrate may be followed by the step of polishing the surface so as to increase the reflective properties, but the polishing may also be done prior  
15 to forming the nano-structure into the bearing substrate so that the surface has the increased shining properties when the nano-structure is formed.

The method may further comprise the step of providing a first substrate on the bearing substrate. A nano-structure may be formed before and after providing the first substrate to  
20 the bearing substrate. When the nano-structure is formed into the bearing substrate after providing the first substrate said nano-structure may be formed into the bearing substrate by means of e.g. a laser.

The method according to the second aspect of the invention may comprise the step of  
25 forming an information surface into the first substrate. The information surface may be provided into the surface of the first substrate being provided to the bearing substrate but could also be provided to the surface facing away from the bearing substrate. The nano-structure of the first substrate may be provided prior to providing the first substrate to the bearing substrate. The method may comprise the step of joining the first substrate to the  
30 bearing substrate by means of gluing or welding or heat sealing.

The method according to the second aspect of the invention may comprise the step of providing a second substrate on the first substrate. A nano-structure may be provided in the same ways of for the first substrate.

35 The method may further comprise the step of forming an information surface into the second substrate. The information surface may be provided in the same way as it may be done on the first substrate.

40 According to the second aspect of the invention the method may further comprise the step of providing a third substrate on the second substrate. A nano-structure may be provided in the same ways of for the first substrate.



Furthermore a step of forming an information surface into the third substrate may be comprised in the method. The information surface may be provided in the same way as it may be done on the first substrate.

- 5 The method may comprise the step of providing a fourth substrate on the third substrate. A nano-structure may be provided in the same ways of for the first substrate. Further the method may comprise the step of forming an information surface into the fourth substrate. The information surface may be provided in the same way as it may be done on the first substrate.
- 10 The method may comprise the step of covering at least one information surface with a reflective material. The information surfaces may be covered with the reflective layer prior or after providing the substrate on which it is formed to another substrate.
- 15 Furthermore the method may comprise the step of forming a curled edge portion extending from a plan defined by the bearing substrate and/or the first substrate and/or the second substrate and/or the third substrate and/or the fourth substrate. The curled edge portion may be formed by means of a stamping process or a curling process and may be formed prior, in-between or after providing the layers of the optical storage medium.
- 20 According to the second aspect of the invention at least a part of the information surface may be formed by a rolling process and/or a stamping process and/or a thermal process and/or an etching process and/or by a cutting process and/or by a electroforming process and/or by an electrolytic process and/or by a magnetic moulding and/or moulding and/or extruding and/or an electro-chemical process.
- 25

The moulding process may be an UV-moulding process or embossing in e.g. a not completely hardened mold (see e.g. WO 00/30854 which is hereby incorporated by reference) or an injection moulding process or any other moulding process. The thermal process may be a laser cutting process or a laser engraving process or any other thermal process. The pressing process may be a hydraulic press process or an excentre press process or any other pressing process.

- 30 The method may comprise any aspect (e.g. fig 7.5 and the pages explaining said figure) of The Compact Disc Handbook (The Computer Music and Digital Audio Series, Vol 5), by Ken C. Pohlmann, Kenneth C. Pohlmann, ISBN: 0895793008

- 35 The method may comprise any aspect of (e.g. fig 5.2 and fig. 5.3 and the pages describing said figure) of
- 40

DVD Demystified, by Jim Taylor, ISBN: 0071350268

The two books are hereby incorporated by reference.

The second aspect of the invention may comprise any feature or means of the first aspect as described in claims 1-75 and on the previous pages.

5 According to a third aspect the invention relates to use of a rolling process for forming an information surface into a substantially non-transparent material, said information surface supporting definition of at least a first nano-structure representing information in digital form.

10 The non-transparent material may be a metallic material. The information surface may comprise a first nano-structure representing information in digital form.

The third aspect of the invention may comprise any feature of the first and/or second aspect of the invention.

15

According to a fourth aspect the invention relates to the use of a stamping process for forming an information surface into a substantially non-transparent material, said information surface supporting definition of at least a first nano-structure representing information in digital form.

20

The non-transparent material may be a metallic material. The information surface may comprise a first nano-structure representing information in digital form.

The fourth aspect of the invention may comprise any feature of the first and/or second

25 and/or third aspect of the invention.

According to a fifth aspect the invention relates to the use of a thermal process for forming an information surface into a substantially non-transparent material, said information surface supporting definition of at least a first nano-structure representing information in

30 digital form.

The non-transparent material may be a metallic material. In an embodiment the non-transparent material may be transparent. The information surface may comprise a first nano-structure representing information in digital form.

35

The fifth aspect of the invention may comprise any feature of the first and/or second and/or third and/or fourth aspect of the invention.

According to a sixth aspect the invention relates to the use of an etching process for

40 forming an information surface into a substantially non-transparent material, said information surface supporting definition of at least a first nano-structure representing information in digital form.

The non-transparent material may be a metallic material. In an embodiment the non-transparent material may be transparent. The information surface may comprise a first nano-structure representing information in digital form.

- 5 The sixth aspect of the invention may comprise any feature of the first and/or second and/or third and/or fourth and/or fifth aspect of the invention.

According to a seventh aspect the invention relates to the use of a cutting process for forming an information surface into a substantially non-transparent material, said

- 10 Information surface supporting definition of at least a first nano-structure representing information in digital form.

The non-transparent material may be a metallic material. In an embodiment the non-transparent material may be transparent. The information surface may comprise a first

- 15 nano-structure representing information in digital form.

The seventh aspect of the invention may comprise any feature of the first and/or second and/or third and/or fourth and/or fifth and/or sixth aspect of the invention.

- 20 According to a eighth aspect the use of an electrolytic process for forming an information surface into a substantially non-transparent material, said information surface supporting definition of at least a first nano-structure representing information in digital form.

- 25 The non-transparent material may be a metallic material. In an embodiment the non-transparent material may be transparent. The information surface comprises a first nano-structure representing information in digital form.

The eighth aspect of the invention may comprise any feature of the first and/or second and/or third and/or fourth and/or fifth and/or sixth and/or seventh aspect of the invention.

- 30 According to a ninth aspect the use of a magnetic moulding process for forming an information surface into a substantially non-transparent material, said information surface supporting definition of at least a first nano-structure representing information in digital form.

- 35 The non-transparent material may be a metallic material. In an embodiment the non-transparent material may be transparent. The information surface comprises a first nano-structure representing information in digital form.

- 40 The ninth aspect of the invention may comprise any feature of the first and/or second and/or third and/or fourth and/or fifth and/or sixth and/or seventh and/or eighth aspect of the invention.

19

According to a tenth aspect the use of a moulding process for forming an information surface into a substantially non-transparent material, said information surface supporting definition of at least a first nano-structure representing information in digital form.

- 5 The non-transparent material may be a metallic material. The information surface comprises a first nano-structure representing information in digital form.

The tenth aspect of the invention may comprise any feature of the first and/or second and/or third and/or fourth and/or fifth and/or sixth and/or seventh and/or eighth and/or

- 10 ninth aspect of the invention.

According to a eleventh aspect the use of an extruding process for forming an information surface into a substantially non-transparent material, said information surface supporting definition of at least a first nano-structure representing information in digital form.

15

The non-transparent material may be a metallic material. In an embodiment the non-transparent material may be transparent. The information surface comprises a first nano-structure representing information in digital form.

- 20 The eleventh aspect of the invention may comprise any feature of the first and/or second and/or third and/or fourth and/or fifth and/or sixth and/or seventh and/or eighth and/or ninth and/or tenth aspect of the invention.

According to a twelfth aspect the use of an electro-chemical process for forming an

- 25 information surface into a substantially non-transparent material, said information surface supporting definition of at least a first nano-structure representing information in digital form.

The non-transparent material may be a metallic material. In an embodiment the non-

- 30 transparent material may be transparent. The information surface comprises a first nano-structure representing information in digital form.

The twelfth aspect of the invention may comprise any feature of the first and/or second and/or third and/or fourth and/or fifth and/or sixth and/or seventh and/or eighth and/or

- 35 ninth and/or tenth and/or eleventh aspect of the invention.

#### **Detailed description of the invention**

An embodiment of the invention will now be described in details with reference to the drawing in which:

40

Figs. 1-6 shows different embodiments of the invention according to the first aspect,

Fig. 7 shows a principle structure of the invention according to the first aspect,

Figs. 8a-8d shows different embodiments of the curl portion according to the first aspect,

Figs. 9a-9b shows different embodiments of stiffness providing means,

5 Fig. 10 shows a cover according to the first aspect of the invention,

Fig. 11 shows a substrate comprising a plurality of information surfaces, and

Fig. 12 shows an embodiment of an optical storage medium, wherein a reflective layer  
10 follows the nano-structure.

Fig. 1 shows an optical storage medium 2 comprising a bearing substrate 4 comprising an information surface 6 on which a nano-structure 8 is provided on a first side 10 of the bearing substrate 4. The bearing substrate is made of a non-transparent material, such as  
15 aluminium or steel or a non-transparent plastic material. A protecting layer 12 is provided on the nano-structure 8. In an embodiment the nano-structure 8 is provided to the protecting layer 12 prior to attaching the protecting layer 12 to the bearing substrate 4. A nano-structure may also be provided on a second side 14 of the bearing substrate (not shown). The second side 14 of the bearing substrate 4 and the outer surface 16 of the  
20 protecting layer 12 are parallel. On the bearing substrate 4 may be provided a plurality of information surfaces 6, such as one, such as two, such as three, such as four or any other number or information surfaces. The information surfaces 8 may be arranged in zones e.g. in four half-circles each comprising an information surface 8. The information surfaces may also have any other shape such as concentric circles or helixes.

25

Fig. 2 shows an optical storage medium 2 according to first aspect of the invention. The optical storage medium 2 comprises a bearing substrate 4 comprising a first layer 16 and a second layer 18 which is provided on two sides of the first layer 16. The first layer 16 is made of steel and the second layer 18 is made of tin. The first layer 16 and the second  
30 layer 18 may also comprise any other kind of non-transparent material. Thus the second layer 18 may serve as protection against corrosion of the first layer 16. On one of the second layers 18 is provided an information surface 6 comprising a nano-structure 8. A protecting layer 12 is provided on top of the nano-structure 8 and thus the nano-structure 8 is also provided in the protecting layer 12. The advantage of the second layer 18 of the  
35 bearing substrate may also be to provide a material in which it is easier to emboss the nano-structure 8, while the first layer 16 provides the desired stiffness of the bearing substrate 4. As described under fig. the bearing substrate 4 may be provided with a plurality of information surfaces 6.

40 Fig. 3 shows an optical storage medium 2 comprising a bearing substrate 4. The bearing substrate 4 is made of a non-transparent material such as a metal. On a first side 10 of the bearing substrate 4 is provided a multi-layer structure 20 comprising a layer 22 comprising an information surface 6 comprising a nano-structure 8. The layer 22 may be a first substrate but could also be a second, third or fourth substrate according to the first

aspect of the invention. On the nano structure 8 is provided a reflective layer 24 enhancing reflection from the nano-structure when an electromagnetic wave e.g. a laser beam is directed towards a upper surface 26 of the layer 22 and transmitted through the layer 22 and reflected by the reflective layer 24. The reflecting layer 24 then reflects the  
5 electromagnetic wave and the nano-structure 8 may be detected by a means for detecting electromagnetic waves. The multi-layer structure 20 is laminated or glued to the bearing substrate 4, by means of a laminating layer 28. The bearing substrate 4 may comprise a number of information surfaces 6.

10 In fig. 4 is shown a bearing substrate 4, which is non-transparent e.g. made of a metal. The bearing substrate 4 may comprise a single layer but could also comprise a plurality of layers as described above. The bearing substrate 4 is provided with a structure supporting layer 30 which may be a lacquer and may be a first, second, third or fourth layer of the invention according to the first aspect of the invention. On the structure supporting layer  
15 30 is provided an information surface 6 comprising a nano-structure 8. On the nano-structure 8 is provided a reflective layer 24. In some applications the reflective layer 24 will be provided as shown in fig. 4 while in others the reflective layer 24 will follow the surface of the nano-structure 8 more smoothly as the thickness of the reflective layer 24 will be substantially equal all over the nano-structure 8 as shown in fig. 12. On the  
20 reflecting layer 24 is provided a protecting layer 12. The protective layer may be a lacquer or a polymer film and could be a first, second, third or fourth layer of the invention according to the first aspect of the invention. In fig 4. the protecting layer 12 is transparent.

25 As described in the preceding some embodiments of the invention according to the first aspect of the invention may comprise a plurality of information surfaces 6a and 6b. An example of this is shown in fig. 5 wherein the optical storage medium 2 comprises two information surfaces 6a and 6b. The optical storage medium 2 comprises a bearing substrate 4. On the bearing substrate is provided a structure supporting layer 30,  
30 comprising a first information surface 6b, which is covered by a reflective layer 24. The first information surface 6b comprises a first nano-structure 8b. On the reflective layer 24 may be provided a second structure supporting layer 31 comprising a second information surface 6a. The second information surface 6a comprises a second nano-structure 8a on which may be provided a semi-reflective layer 32. The second structure supporting layer  
35 31 may be semi-transparent. On the semi-reflective layer 32 is provided a protecting layer 12.

In fig. 6 is provided a bearing substrate 4 on which is provided a structure supporting layer 30. On the structure supporting layer 30 is provided a first information surface 6b  
40 comprising a first nano-structure 8b. The first information surface 6b is covered by a reflective layer 24. On the reflective layer is provided a second structure supporting layer 31 comprising the second information surface 6a which comprises a second nano-structure 8a. The second structure supporting layer 31 may be semi-transparent. The second information surface 6a is covered by a protecting layer 12.

- Fig 7. shows a multi-layer structure according to the first aspect of the invention. The multi-layer structure comprises a first substrate 34, a second substrate 36 and a third substrate 38. The first substrate 34 comprises a first surface 40 and a second surface 42.
- 5 The second substrate 36 comprises a first surface 44 and a second surface 46. The third substrate 38 comprises a first surface 48 and a second surface 50. Any of the first surfaces 40, 44, 48 and any of the second surfaces 42, 46, 50 may comprise one or more information surfaces which may comprise one or more nano-structures. As an example one of the surfaces may comprise four information surfaces grouped in four zones dividing the
- 10 surface into four half circles. Any other number of Information surfaces may be provided on a surface. On any information surface may be provided a reflective layer or the substrate may be made of a reflective layer which may be reflective with or without being polished.
- 15 Figs. 8a-8d, 9a-9b and 10 shows different embodiments of curl portions 52 of the optical storage medium 2 having a centre axis 54 and an information surface 6. The thickness 56 of the curl portion 52 is determined as shown in the figure. Figs. 9a and 9b further shows stiffness supporting means 58. Fig. 10 further shows a cover 60 comprising a surface 62 on which information about the content of the optical storage medium 2 is provided. The
- 20 cover 60 may be quadrangular.

- Fig. 11 shows a optical storage medium 2 having a centre axis 54 and comprising a plurality of information surfaces i.e. a first information surface 64, a second information surface 66, a third information surface 68 and a fourth information surface 70. Any other
- 25 number of information surfaces may be provided on a surface of the optical storage medium and the information surfaces may have any shape.

- In Fig. 12, the nano-structure of an information surface 6 is covered with a reflective layer 24. The reflective layer is covered with a layer of protective lacquer 121 or with similar
- 30 means for protecting the surface of the reflective layer. The reflective layer is provided so that both surfaces thereof, i.e. the surface facing the information surface and the surface facing the protective lacquer narrowly follows the contour of the information surface. Accordingly, the two surfaces of a reflective material both forms contours representing the same information.

CLAIMS

1. An optical storage medium comprising at least one information surface supporting definition of at least a first nano-structure representing information in digital form, the  
5 optical storage medium further comprising a bearing substrate comprising a substantially non-transparent material.
2. An optical storage medium according to claim 1, wherein the information surface comprises a first nano-structure representing information in digital form.
- 10 3. An optical storage medium according to claim 1 or 2, wherein the information surface makes the optical storage medium recognisable for an optical detecting device.
4. An optical storage medium according to any of claims 1-3, wherein the bearing  
15 substrate comprises at least one metallic material.
5. An optical storage medium according to any of claims 1-4, wherein the bearing substrate is a non-metallic material selected from the group consisting of glass, polymers, elastomers, paper, cardboard, wood or any combination thereof.
- 20 6. An optical storage medium according to any of the preceding claims, further comprising a second nano-structure supporting definition of the first nano-structure.
7. An optical storage medium according to any of claims 1-6, wherein the information  
25 surface comprises at least one geometrical structure supporting definition of the first nano-structure.
8. An optical storage medium according to claim 7, wherein the geometrical structure comprises a first zone defining a first nano-structure and/or a second zone defining the  
30 second nanostructure.
9. An optical storage medium according to claims 7 or 8, wherein the geometrical structure forms a helix.
- 35 10. An optical storage medium according to any of claims 7-9, wherein the optical storage medium comprises a plurality of concentric geometrical structures.
11. An optical storage medium according to any of the preceding claims, wherein the bearing substrate comprises a first and an opposite second surface, at least one of said  
40 surfaces comprising at least one information surface.
12. An optical storage medium according to any of the preceding claims, further comprising a first substrate having a first and a second surface, the first substrate being substantially parallel to a plane defined by the bearing substrate.



13. An optical storage medium according to claim 12, wherein at least one of the first and the second surfaces of the first substrate comprises at least one information surface.

5 14. An optical storage medium according to any of the preceding claims, further comprising a second substrate having a first and a second surface, the second substrate being substantially parallel to a plane defined by the bearing substrate.

15. An optical storage medium according to claim 14, wherein at least one of the first and  
10 the second surfaces of the second substrate comprises at least one information surface.

16. An optical storage medium according to any of the preceding claims, further comprising a third substrate having a first and a second surface, the third substrate being substantially parallel to a plane defined by the bearing substrate.

15 17. An optical storage medium according to claim 16, wherein at least one of the first and the second surfaces of the third substrate comprises at least one information surface.

18. An optical storage medium according to any of the preceding claims, further  
20 comprising a fourth substrate having a first and a second surface, the fourth substrate being substantially parallel to a plane defined by the bearing substrate.

19. An optical storage medium according to claim 18, wherein at least one of the first and the second surfaces of the fourth substrate comprises at least one information surface.

25 20. An optical storage medium according to any of the preceding claims, wherein at least a part of at least one information surface is covered with a reflective layer.

21. An optical storage medium according to claim 20, wherein the reflective layer  
30 comprises a metallic material.

22. An optical storage medium according to of claims 12-21, wherein at least one information surface of the bearing substrate is reflective.

35 23. An optical storage medium according to any of claims 12-22, further comprising a multi-layer structure provided on the first surface of the bearing substrate.

24. An optical storage medium according to any of claims 12-23, further comprising a multi-layer structure provided on the second surface of the bearing substrate.

40 25. An optical storage medium according to claim 23 or 24, wherein the multi-layer structure comprises the first substrate and/or the second substrate and/or the third substrate and/or the fourth substrate.

26. An optical storage medium according to any of claims 23-25, wherein the multi-layer structure comprises the first substrate, at least a part of said first substrate being connected to the surface on the bearing substrate on which the multi-layer structure is provided.

5

27. An optical storage medium according to any of claims 23-26, wherein the multi-layer structure further comprises the second substrate, at least a part of said second substrate being connected to a surface of the first substrate.

10 28. An optical storage medium according to any of claims 23-27, wherein the multi-layer structure further comprises the third substrate, at least a part of said third substrate being connected to a surface of the second substrate.

15 29. An optical storage medium according to any of claims 23-28, wherein the multi-layer structure further comprises the fourth substrate, at least a part of said fourth substrate being connected to a surface of the third substrate.

20 30. An optical storage medium according to any of claims 14-29, wherein the propagation rate of an electromagnetic wave in the first substrate is lower than the propagation rate of the electromagnetic wave in the second substrate.

31. An optical storage medium according to any of claims 14-30, wherein the coefficient of reflection of the first substrate is higher than the coefficient of reflection of the second substrate, such as 10 percentage points higher, such as 20 percentage points higher, such as 30 percentage points higher, such as 40 percentage points higher, such as 50 percentage points higher, such as 60 percentage points higher, such as 70 percentage points higher, such as 80 percentage points higher, such as 90 percentage points higher.

30 32. An optical storage medium according to any of claims 16-31, wherein the propagation rate of an electromagnetic wave in the second substrate is lower than the propagation rate of the electromagnetic wave in the third substrate.

35 33. An optical storage medium according to any of claims 16-32, wherein the coefficient of reflection of the second substrate is higher than the coefficient of reflection of the third substrate, such as 10 percentage points higher, such as 20 percentage points higher, such as 30 percentage points higher, such as 40 percentage points higher, such as 50 percentage points higher, such as 60 percentage points higher, such as 70 percentage points higher, such as 80 percentage points higher, such as 90 percentage points higher.

40 34. An optical storage medium according to any of claims 18-33, wherein the propagation rate of an electromagnetic wave in the third substrate is lower than the propagation rate of the electromagnetic wave in the third substrate.

35. An optical storage medium according to any of claims 18-34, wherein the coefficient of reflection of the third substrate is higher than the coefficient of reflection of the fourth substrate, such as 10 percentage points higher, such as 20 percentage points higher, such as 30 percentage points higher, such as 40 percentage points higher, such as 50  
5 percentage points higher, such as 60 percentage points higher, such as 70 percentage points higher, such as 80 percentage points higher, such as 90 percentage points higher.
36. An optical storage medium according to any of claims 18-35, wherein the first  
10 substrate and/or second substrate and/or the third substrate and/or the fourth substrate is a semi-transparent material.
37. An optical storage medium according to any of claims 18-36, wherein the first  
substrate and/or the second substrate and/or the third substrate and/or the fourth  
substrate is a transparent substrate.  
15
38. An optical storage medium according to any of claims 18-37, wherein at least one  
substrate of the multi-layer structure is a peelable foil adhesively bonded to the bearing  
substrate and/or a substrate of the multi-layer structure.
- 20 39. An optical storage medium according to claim 38, wherein the peelable foil comprises a  
slip for removal of the foil from the substrate.
40. An optical storage medium according to claim 38 or 39, wherein the peelable foil in a  
pealed state is non-re-applicable to a surface of the optical storage medium.  
25
41. An optical storage medium according to any of the preceding claims, further  
comprising a supporting means extending from a plan defined by the bearing substrate  
and/or the multi-layer structure.
- 30 42. An optical storage medium according to claim 41, wherein the supporting means is  
formed by a curled edge portion of the bearing substrate and/or the multi-layer structure  
substrate.
43. An optical storage medium according to any of the preceding claims, wherein the  
35 storage medium is provided with a centre hole.
44. An optical storage medium according to claim 43, wherein the curled edge-portion is  
formed along an edge of the centre hole.
- 40 45. An optical storage medium according to any of claims 42-44, wherein the curled edge-  
portion is formed along an outer peripheral edge of the bearing substrate and/or the multi-  
layer structure.

46. An optical storage medium according to claim 45, wherein the curled edge portion of the centre hole and the curled edge portion of the outer peripheral edge extends in substantially the same direction in relation to the plan defined by the bearing substrate and/or the multi-layer structure.

5

47. An optical storage medium according to any of the preceding claims, further comprising detachable protecting means for protecting at least a part of the nano-structure.

10 48. An optical storage medium according to claim 49, wherein the protecting means is adapted to engage the centre hole of the substrate.

49. An optical storage medium according to claims 47 or 48, wherein the peripheral surface of the protecting means is shaped as a polygon, such as a quadrangle or a

15 triangle.

50. An optical storage medium according to any of the preceding claims, wherein the bearing substrate is made of a metal or an alloy, the metal or alloy comprising iron and/or steel and/or aluminium and/or magnesium and/or titanium and/or copper and/or nickel  
20 and/or zinc and/or cadmium and/or tin and/or lead and/or chrome and/or wolfram and/or silver and/or gold and/or platinum and/or stainless steel and/or tinplate and/or molybdenum.

51. An optical storage medium according to any of claims 18-50, wherein the first  
25 substrate and/or second substrate and/or third substrate and/or the fourth substrate comprises a non-metallic material.

52. An optical storage medium according to claim 51, wherein the non-metallic material is  
30 selected from the group consisting of lacquers, polymers, elastomers, laminated plastic, printing inks or any combination thereof.

53. An optical storage medium according to any of claims 18-52, wherein the reflective layer comprises a highly refractive material selected from the group consisting of  
35 aluminium, silver, gold, platinum, chrome, titanium dioxide and zirconium dioxide and any combination thereof.

54. An optical storage medium according to any of the preceding claims, wherein the thickness of the bearing substrate is selected within the range 100-1400  $\mu\text{m}$ , such as  
40 within the range 125-1000  $\mu\text{m}$ , such as within the range 150-800  $\mu\text{m}$ , such as within the range 175-600  $\mu\text{m}$ , such as within the range 200-400  $\mu\text{m}$ , such as 225 $\mu\text{m}$ , such as 250  $\mu\text{m}$  such as 275  $\mu\text{m}$ , such as 300  $\mu\text{m}$ , such as 325  $\mu\text{m}$ , such as 350 $\mu\text{m}$ , such as 375 $\mu\text{m}$ .

55. An optical storage medium according to any of claims 12-54, wherein the thickness of the first substrate is selected within the range 0,1-1000  $\mu\text{m}$ , such as within the range 0,5-750  $\mu\text{m}$ , such as within the range 1-500  $\mu\text{m}$ , such as within the range 1,5-250  $\mu\text{m}$ , such as within the range 2-75  $\mu\text{m}$ , such as within the range of 5-10  $\mu\text{m}$ , such as within the range  
5 of 100-300  $\mu\text{m}$ .

56. An optical storage medium according to any of claims 14-55, wherein the thickness of the second substrate is selected within the range 0,1-500  $\mu\text{m}$ , such as within the range 2-450  $\mu\text{m}$ , such as within the range 4-400  $\mu\text{m}$ , such as within the range 6-350  $\mu\text{m}$ , such as  
10 within the range 8-325  $\mu\text{m}$ , such as within the range of 10-300 $\mu\text{m}$ .

57. An optical storage medium according to any of claims 16-56, wherein the thickness of the third substrate is selected within the range 0,1-500  $\mu\text{m}$ , such as within the range 2-450  $\mu\text{m}$ , such as within the range 4-400  $\mu\text{m}$ , such as within the range 6-350  $\mu\text{m}$ , such as  
15 within the range 8-325  $\mu\text{m}$ , such as within the range of 10-300 $\mu\text{m}$ .

58. An optical storage medium according to any of claims 18-57, wherein the thickness of the fourth substrate is selected within the range 0,1-500  $\mu\text{m}$ , such as within the range 2-450  $\mu\text{m}$ , such as within the range 4-400  $\mu\text{m}$ , such as within the range 6-350  $\mu\text{m}$ , such as  
20 within the range 8-325  $\mu\text{m}$ , such as within the range of 10-300 $\mu\text{m}$ .

59. An optical storage medium according to any of claims 21-58, wherein the thickness of the reflective layer is selected within the range of 0,01-1 $\mu\text{m}$ , such as within the range of 0,02-0,09  $\mu\text{m}$ , such as within the range of 0,03-0,08  $\mu\text{m}$ , such as within the range of 0,04-  
25 0,07  $\mu\text{m}$ , such as within the range of 0,05-0,06  $\mu\text{m}$ , such as 0,05  $\mu\text{m}$ .

60. An optical storage medium according to any of claims 21-59, wherein at least one of the reflective layers comprises an active reflective layer which may be changed between a non-reflective position and a reflective position.  
30

61. An optical storage medium according to claim 60, wherein the active reflective layer comprises floating crystals adapted to be changed between the two positions.

62. An optical storage medium according to any of the preceding claims, wherein the  
35 thickness of the curl portion is within the range 100-1500  $\mu\text{m}$ , such as within the range 300-1400  $\mu\text{m}$ , such as within the range 500-1350  $\mu\text{m}$ , such as within the range 750-1300  $\mu\text{m}$ , such as within the range 1000-1250  $\mu\text{m}$ , such as substantially 1200  $\mu\text{m}$ .

63. An optical storage medium according to any of the preceding claims, wherein the  
40 bearing substrate and/or the first substrate and/or the second substrate and/or the third and/or the fourth substrate is provided with a colour print layer.

64. An optical storage medium according to claim 63, wherein the colour print layer is positioned between the bearing substrate and the first substrate.

65. An optical storage medium according to claims 63 or 64, wherein the colour print layer is positioned between the first substrate and the second substrate.
- 5 66. An optical storage medium according to any of claims 63-65, wherein the colour print layer is positioned between the second substrate and the third substrate.
67. An optical storage medium according to any of claims 63-66, wherein the colour print layer is positioned between the third substrate and the fourth substrate.
- 10 68. An optical storage medium according to any of claims 63-67, wherein the colour print layer is provided on a side of the fourth substrate opposite the third substrate.
69. An optical storage medium according to any of claims 18-68, wherein at least one  
15 substrate in the multi-layer structure is coloured.
70. An optical storage medium according to any of the preceding claims, wherein the digital information represented in the nano-structure is audio and/or video and/or data, such as data for a computer, such as data for a computer game application.
- 20 71. An optical storage medium according to any of the preceding claims, wherein the nanostructure represents an image and/or text, such as a hologram.
72. An optical storage medium according to any of the preceding claims, wherein the  
25 optical storage medium is a Compact Disc, such as an audio CD, such as a super audio CD.
73. An optical storage medium according to any of the preceding claims, wherein the optical storage medium is a CD-ROM, such as a read-only CD-ROM, such as a recordable CD-ROM, such as a re-writable CD-ROM.
- 30 74. An optical storage medium according to any of the preceding claims, wherein the optical storage medium is a multi-layer medium, such as a DVD, such as a DVD+R/W such as a DVD-R/W such as a DVD-ROM.
- 35 75. An optical storage medium according to any of the preceding claims, wherein the optical storage medium is a disc-drive medium, such as a floppy disc such as a hard disc.
76. An optical storage medium according to any of the preceding claims, wherein the optical storage medium is adapted to be read by laser-source and/or an x-ray-source  
40 and/or an magnetic-resonance source.
78. A method of making an optical storage medium comprising a bearing substrate, the bearing substrate comprising a substantially non-transparent material, said method comprising the steps of:

forming an information surface into a surface of the optical storage medium, the information surface supporting definition of a first nano-structure representing information in digital form.

5

79. A method according to claim 78, further comprising the step of forming a first nano-structure into the information surface, the first nano-structure representing information in digital form.

10 80. A method according to claim 78 or 79, wherein the information surface is provided on the bearing substrate.

81. A method according to claims 78-80, further comprising the step of providing a first substrate on the bearing substrate.

15

82. A method according to any of claims 78-81, further comprising the step of forming an information surface into the first substrate

20 83. A method according to claims 78-82, further comprising the step of providing a second substrate on the first substrate.

84. A method according to any of claims 78-83, further comprising the step of forming an information surface into the second substrate.

25 85. A method according to claims 78-84, further comprising the step of providing a third substrate on the second substrate.

86. A method according to any of claims 78-85, further comprising the step of forming an information surface into the third substrate.

30

87. A method according to claims 78-86, further comprising the step of providing a fourth substrate on the third substrate.

35 88. A method according to any of claims 78-87, further comprising the step of forming an information surface into the fourth substrate.

89. A method according to any of claims 78-88, further comprising the step of covering at least one information surface with a reflective material.

40 90. A method according to any of claims 78-89, further comprising the step of forming a curled edge portion extending from a plan defined by the bearing substrate and/or the first substrate and/or the second substrate and/or the third substrate and/or the fourth substrate.

91. A method according to any of claims 78-90, wherein at least a part of the information surface is formed by a rolling process and/or a stamping process and/or a thermal process and/or an etching process and/or by a cutting process and/or by an electroforming process and/or by an electrolytic process and/or by a magnetic moulding and/or moulding and/or extruding and/or an electro-chemical process.

92. The use of a rolling process for forming an information surface into a substantially non-transparent material, said information surface supporting definition of at least a first nano-structure representing information in digital form.

10

93. The use of a rolling process according to claim 92, wherein the information surface comprises a first nano-structure representing information in digital form.

94. The use of a stamping process for forming an information surface into a substantially non-transparent material, said information surface supporting definition of at least a first nano-structure representing information in digital form.

15

95. The use of a stamping process according to claim 94, wherein the information surface comprises a first nano-structure representing information in digital form.

20

96. The use of a thermal process for forming an information surface into a substantially non-transparent material, said information surface supporting definition of at least a first nano-structure representing information in digital form.

97. The use of a thermal process according to claim 96, wherein the information surface comprises a first nano-structure representing information in digital form.

25

98. The use of an etching process for forming an information surface into a substantially non-transparent material, said information surface supporting definition of at least a first nano-structure representing information in digital form.

30

99. The use of an etching process according to claim 98, wherein the information surface comprises a first nano-structure representing information in digital form.

100. The use of a cutting process for forming an information surface into a substantially non-transparent material, said information surface supporting definition of at least a first nano-structure representing information in digital form.

35

101. The use of a cutting process according to claim 100, wherein the information surface comprises a first nano-structure representing information in digital form.

40

102. The use of a cutting process for forming an information surface into a substantially non-transparent material, said information surface supporting definition of at least a first nano-structure representing information in digital form.



103. The use of a cutting process according to claim 102, wherein the information surface comprises a first nano-structure representing information in digital form.
- 5 104. The use of a magnetic moulding process for forming an information surface into a substantially non-transparent material, said information surface supporting definition of at least a first nano-structure representing information in digital form.
- 10 105. The use of a magnetic moulding process according to claim 104, wherein the information surface comprises a first nano-structure representing information in digital form.
- 15 106. The use of a moulding process for forming an information surface into a substantially non-transparent material, said information surface supporting definition of at least a first nano-structure representing information in digital form.
107. The use of a moulding process according to claim 106, wherein the information surface comprises a first nano-structure representing information in digital form.
- 20 108. The use of an extruding process for forming an information surface into a substantially non-transparent material, said information surface supporting definition of at least a first nano-structure representing information in digital form.
- 25 109. The use of an extruding process according to claim 108, wherein the information surface comprises a first nano-structure representing information in digital form.
110. The use of an electro-chemical process for forming an information surface into a substantially non-transparent material, said information surface supporting definition of at least a first nano-structure representing information in digital form.
- 30 111. The use of an electro-chemical process according to claim 110, wherein the information surface comprises a first nano-structure representing information in digital form.

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Modtaget

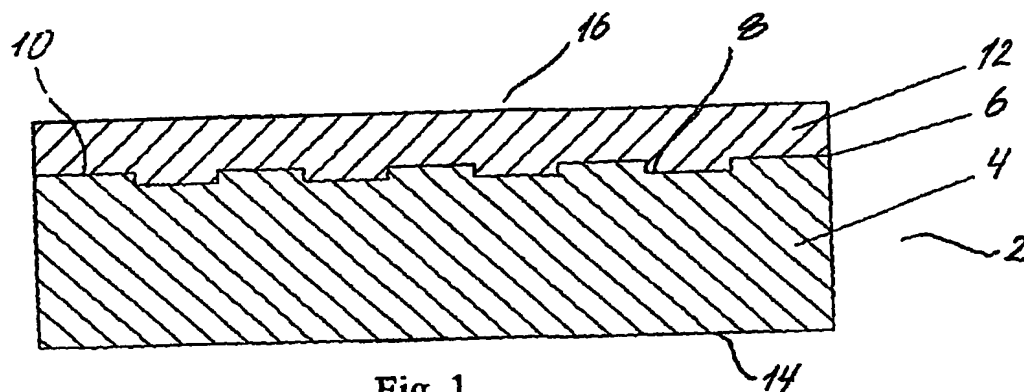


Fig. 1

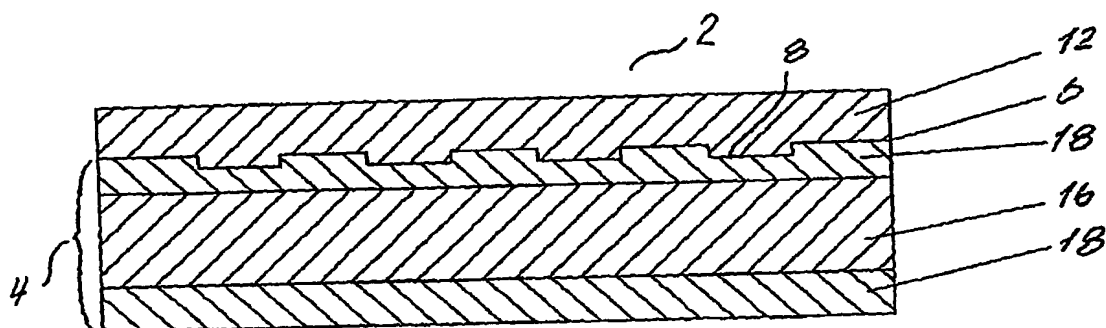


Fig. 2

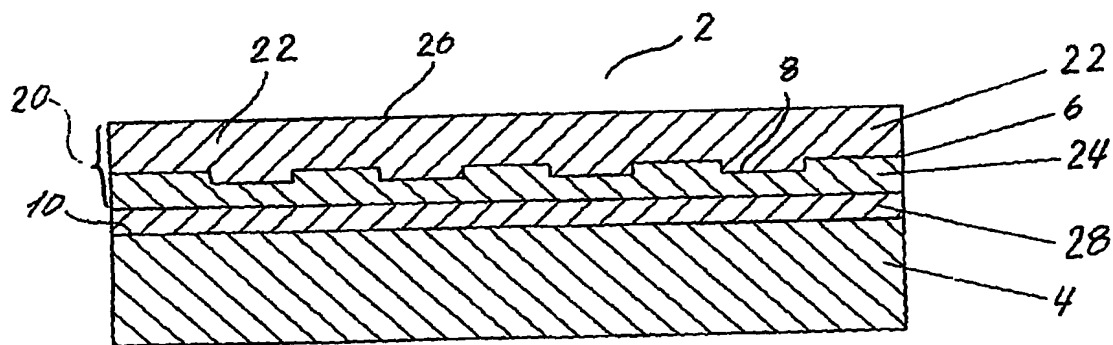


Fig. 3

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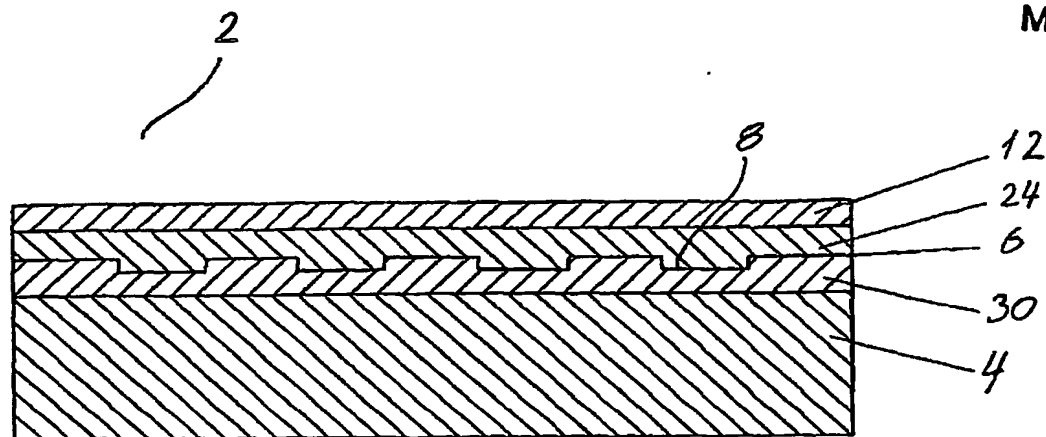


Fig. 4

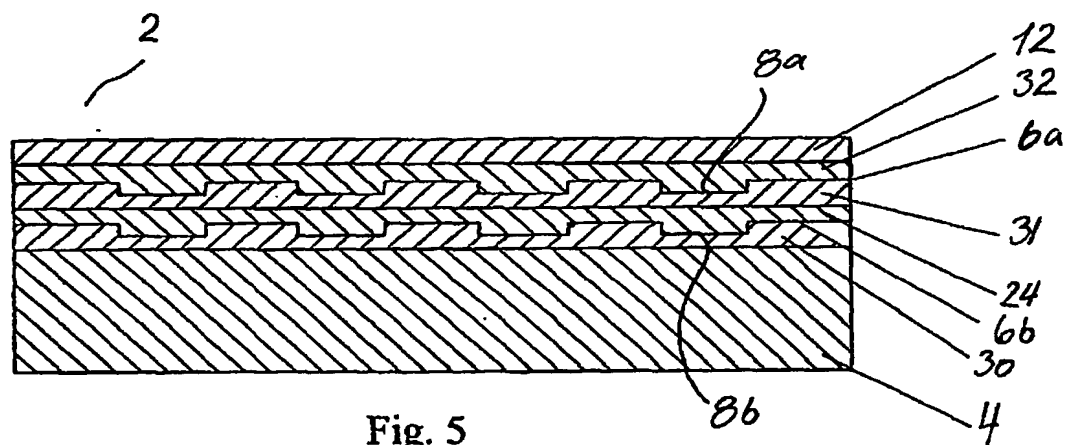


Fig. 5

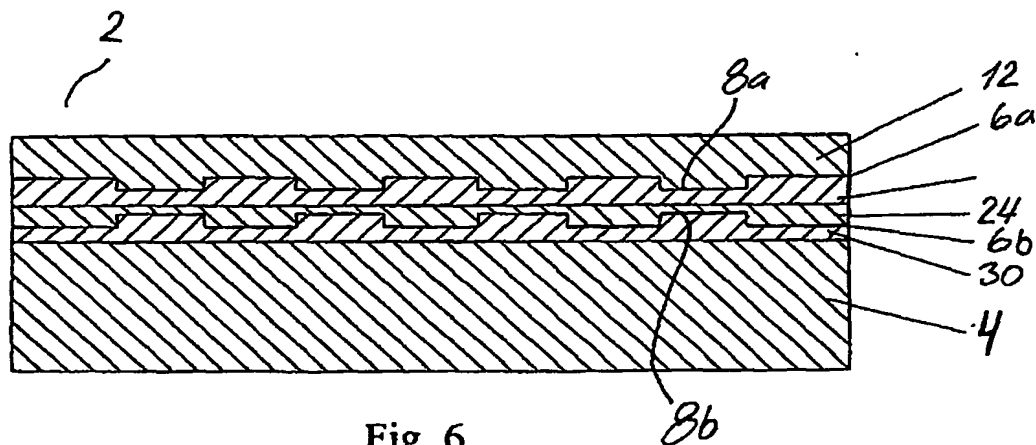


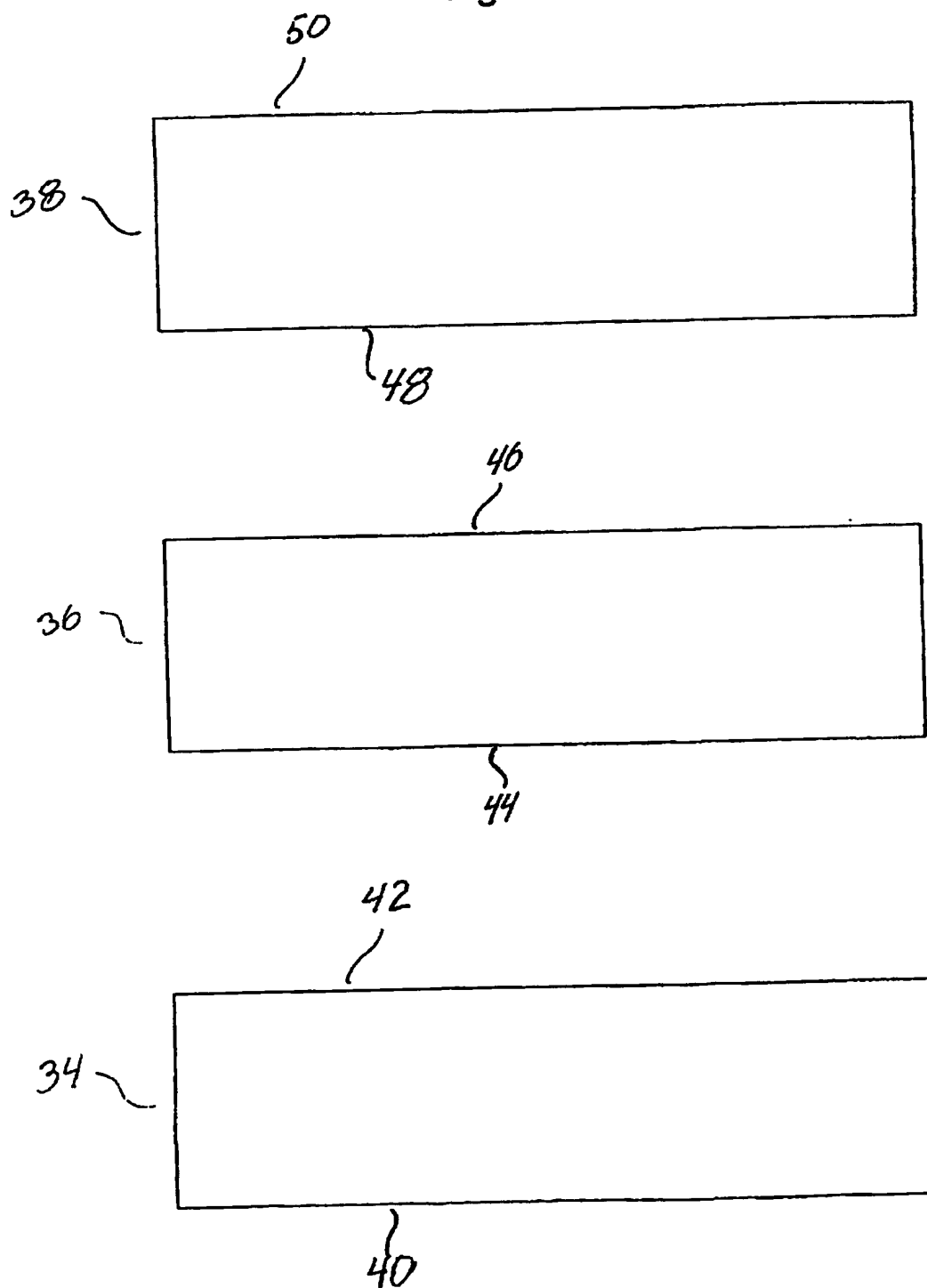
Fig. 6

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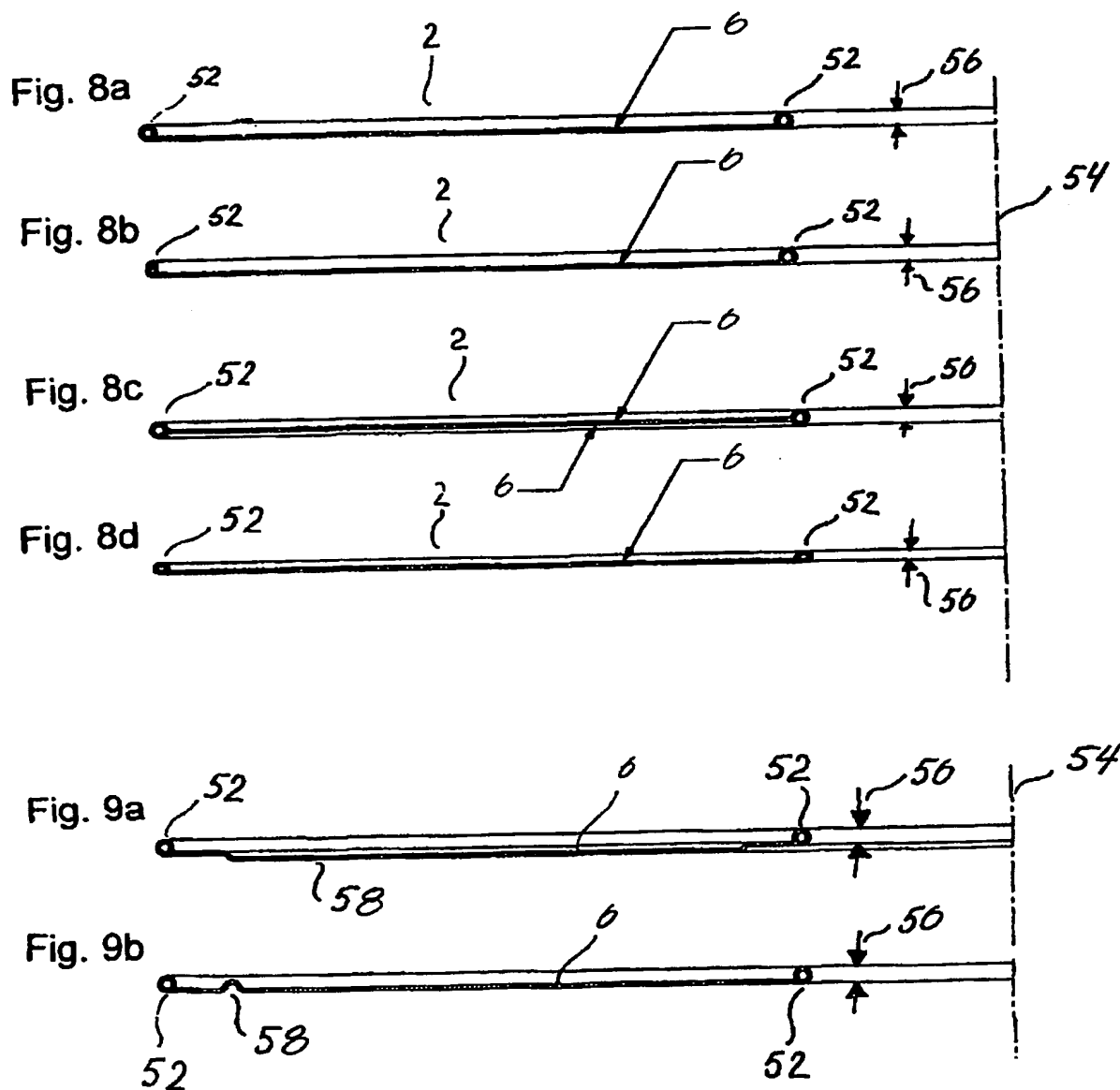
Fig. 7



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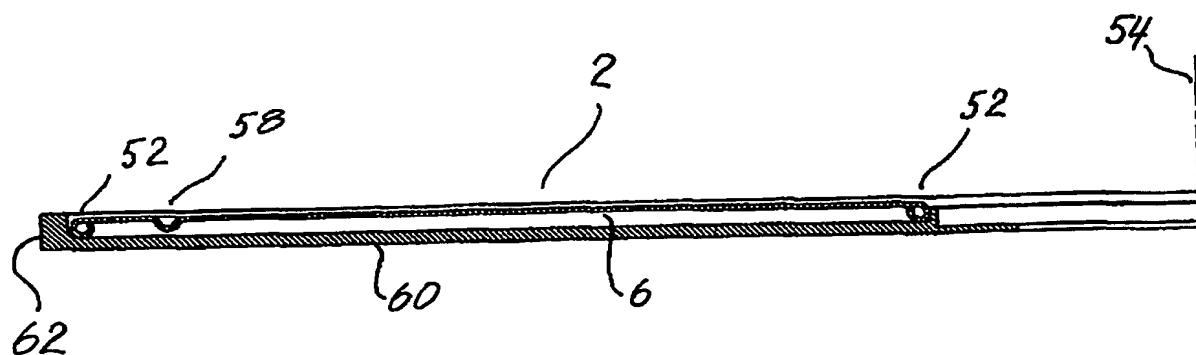


Fig. 10a

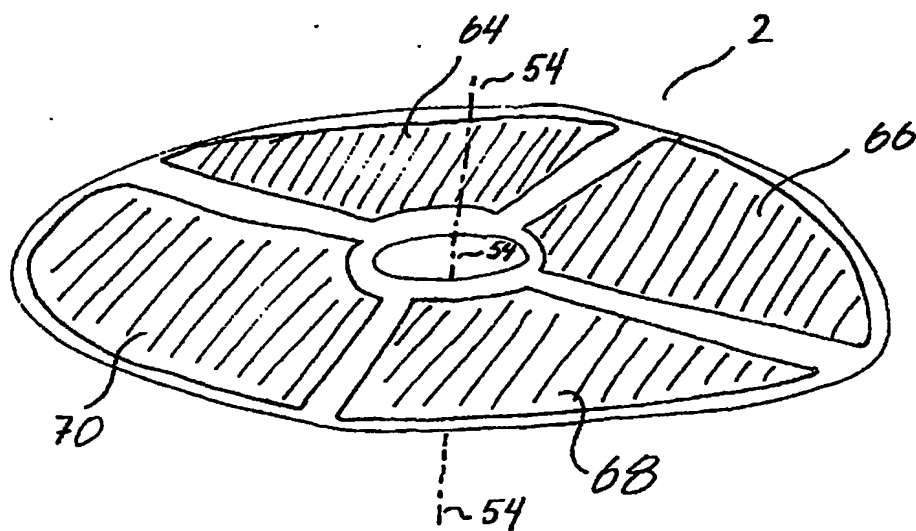
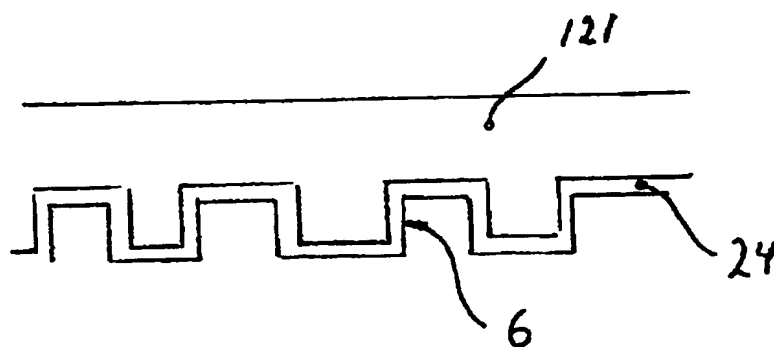


Fig. 11

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**Fig. 12**

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